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ABSTRACT

This paper considers the sources and education of an adequate supply of technicians to ensure New Zealand's technological future. It deals with such questions as the source of technicians, and what their learning experiences and outcomes should be. Included in the paper are specific sections dealing with: (1) "Authority for Advanced Vocational Awards (AAVA)"; (2) "Government and Education"; (3) "The TI System"; (4) "'The Key to Prosperity: Science and Technology'"; (5) "Industry"; (6) "Identifying Needs, Responding to Demand"; (7) "Shortages in the Foreseeable Future"; (8) "Mathematics, Science and the Learner"; (9) "Related Considerations of Curriculum"; (10) "The Foreseeable Future"; (11) "Credentialism"; and (12) "Myths and Targets." The appendix contains the "Policy Statement on Standards and Routes to Registration," from the Engineering Council (London). (TW)

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TECHNICIANS, EDUCATION AND EQUITY

- with the benefit of foresight?

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Author's Note

The Conference Objective was:

> "To make recommendations for action by Government and industry to achieve and maintain an adequate supply of technicians to ensure New Zealand's technological future."

The author was invited to present a paper giving a contrasting view to that of Professor H. McCallion of Canterbury University on the functions of existing bodies in the field of technician education and training along with recommendations for the future; in addition to prepare points for discussion and to draft recommendations for possible adoption.

Background papers distributed before the conference included:

IMRIE, B.W. **"The Technician in New Zealand"** Paper 85/32 Authority for Advanced Vocational Awards, Wellington, 1985 a

IMRIE, B.W, McCALLION, H., THOMAS, R.F. **"Providing Technicians for Research and Development"** Science and Technology Reviews. Wellington: National Research Advisory Council of NZ, 1985

TECHNICIANS, EDUCATION AND EQUITY
- with the benefit of foresight?

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Abstract

In his paper "On Developing People for Technician Engineer Roles", McCallion asserts that in New Zealand there is no system, merely a loose network, for developing a person's abilities to fill a technician-engineer role (or, for that matter, the role of a technician scientist, technician builder, etc). McCallion refers to components of the network as employers of learners, AAVA, technical institutes (TIA, ATTI, etc) and the Department of Education.

In considering the implications of an adequate supply of technicians to ensure New Zealand's technological future, this paper considers these network components with particular reference to a common denominator - the future technician or learner in the system. Where will the learners come from? What should be their learning experiences and outcomes? In this regard reference will also be made to the opening paper on technological skills by Griffin.

While the conference, itself, represents an excellent opportunity to share insights and experiences directly there is an extensive experience available in numerous publications. There is thus opportunity to consider the historical experience of technician training in NZ and also the contemporary experiences of other countries facing a similar problem. This paper and a conference background paper (Imrie, 1985a) draw on such experiences.

The paper also considers recent Government policy and the Beattie Report on science and technology "Key to Prosperity".

For the learner, the concept of equity is considered to be particularly important. It transcends myths of NZ education identified by Beeby (architect of the NZ TI system) and relates to the need to involve industry much more systematically at all stages of the development of technicians for the future of New Zealand.

"Technicians for the Hi-Tech Future" (IPENZ, 1987)

TECHNICIANS, EDUCATION AND EQUITY

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INTRODUCTION

In this paper I wish to develop some of the considerations dealt with by Mr D J Griffin in his opening address to this conference and also to take up the themes addressed by Professor H McCallion. While reference will be made to some aspects of the historical development of technician education (and training) in this paper, and in a background paper (Imrie 1985), further consideration will be given to issues of education and equity for the provision of technicians for the "hi-tech" future of New Zealand.

McCallion has been properly careful to define the role of the technician engineer. Similar considerations will also apply to other categories such as the technician scientist and the technician builder with education and training experiences and outcomes represented by the New Zealand Certificate (NZC) awarded by the Authority for Advanced Vocational Awards (AAVA). In the UK, the Engineering Council (1984) has included definitions of the Technician Engineer and the Engineering Technician and these are included in an appendix for completeness. These definitions are consistent with those presented by McCallion, but it is appropriate to note the following statement:

> "Technician Engineers provide, either independently or as leaders, the most satisfactory service possible through existing resources and so exercise a significant influence on the overall effectiveness of the organisation in which they work."

Another term which should be defined, or at least clarified, is "hi-tech". For the purposes of this paper high technology is considered basically to be the application of information-based high speed control to the operation and improved performance of equipment and systems. Control and improved performance of dynamic systems are related to speed of response and of interpretation of control information. The appropriate high speed processing of information and subsequent derived decisions which improve performance as part of the function of mechanisms or systems, are a function of the speed of electronic responses controlled by silicon-chip or laser-light technology. Adaptive or intelligent response is then possible for the design of equipment or system software.

Thus, information technology (IT) is central to these concepts of high technology; IT is defined by UNESCO as:

> "Scientific, technological and engineering disciplines and the management techniques used in information handling and processing; their applications; computers and their interaction with man and machines; and associated social, economic and cultural matters."

It is on this basis that the Central Institute of Technology established, in 1986, a Centre for Information Technology (CITEC) to promote innovation and development in IT with particular reference to meeting the needs of industry for training and consultancy.

It is worth noting that the Beattie Report (1986) "Key to Prosperity : Science and Technology" adopted a definition of innovation as "the transformation of an idea into a new or improved saleable product or operational process in industry or commerce" (OECD 1981). The Beattie Report exhorts the government to ensure that

> "our educational system produces the technically trained and literate people needed at all levels in industry" (p vii).

It charts new waters by recommending investigation of "staffing and other resources needed to allow for research and development in selected areas in technical institutes". Indeed this was the theme of the CIT submission to the Working Party chaired by Sir David Beattie

In the introduction to this paper I have introduced considerations to which further reference will be made. I am mindful that this conference is an exercise in problem solving and I will conclude this introduction by referring to "Education for Capability" (Ed. Burgess 1986). I believe that this work, although about the UK experience, is also relevant to NZ education and is important in that it provides a coherent analysis of the educational failures of the past in providing for the present and future needs of our society. For this conference it is, therefore, particularly appropriate to note the implications of the statement:

> "The characteristics of engineering problems - the transformation from one state of affairs to another - are characteristics of all real world practical problems". (p 105)

In November 1986, the transformation of the state of affairs relating to technician training in NZ started with pronouncements by the Minister of Education in his address to the Technical Institute Association (TIA) Conference in November 1986. The Minister indicated that all regional institutes should have the general title of polytechnic or community polytechnic rather

than technical institutes and community colleges.

The Ministers of Education and Employment have agreed that concurrent employment should no longer be a prerequisite for trade or technician level training. The Minister has approved all full-time courses of 12 weeks duration or more to qualify for Tertiary Assistance Grant purposes. He has also approved the convening of a working group to consider the relevance of the Scottish 16+ Development Programme (referred to by Griffin) to the NZ situation and, finally, indicated that the future of AAVA, TCB and VTC was being reviewed.

Later that month the transformation of technician training was given a focus by the announcement of a pilot programme of four technician courses leading to a national certificate. Students entering from sixth form would qualify by completing two years full-time study, including structured practical experience, at a technical institute. CIT will offer one of the pilot courses leading to a National Certificate in Electronic Engineering. In the interim this course will be validated by AAVA and subsequently (post-AAVA) by a proposed national validation authority.

With the announcement by the Minister of a Review of Tertiary Education which will include all sectors funded through Vote Education, 1987 will be a year of radical transformation to the technical institute system and to the education and training of technicians.

In the next sections some aspects of the components of the system or network are considered.

THE AUTHORITY FOR ADVANCED VOCATIONAL AWARDS (AAVA)

Speakers have already described the history and work of AAVA with reference to the Vocational Awards Act 1979. Reference has been made to the NZ Certificate (technician engineer) and the Technicians Certificate (engineering technician). Historically, the NZ Certificate has required five stages of study equivalent approximately to two years full-time study (TI full-time year to 36 weeks) in conjunction with three years of work experience, two of which were required to be prior or concurrent for part-time study of Stages 4 and 5. On 29 January 1987, in deference to the Minister's formal request, the Authority resolved that prior or concurrent work experience would no longer be a mandatory condition. With three years suitable work experience after completing the study requirements, students would qualify for the NZC award after satisfactorily completing a project based on their work experience.

In 1983, the Authority extended its national responsibilities for prescribing and examining for technician qualifications

to include that of validating, ie approving the validity of courses developed and provided by teaching institutions or other organisations. For this purpose, under the chairmanship of D J Griffin, the Authority introduced a new set of awards or "National Qualifications" (AAVA 1983). Under the chairmanship of H E Hutchings the first courses were validated and procedures developed to cope with increasing demand. For example, the two year full-time National Certificate in Business Studies (with no work experience) has replaced the NZ Certificate in Commerce which, like other NZ Certificates, required prior or concurrent work experience for study of Stage 4 and Stage 5 subjects.

In educational terms validation is a form of quality assurance with reference to content, levels of learning and assessment of outcomes. In this last regard validation also ensures reliability or consistency in the standard of a qualification - nationally.

The Authority has, therefore, developed as a national body with reliable procedures for validation based on provisions in the Vocational Awards Act 1979. The current Acting Director General of Education, Mr J A Ross, made a significant contribution to the drafting of the Act. As stated previously, the Department now intends to set up a national validation authority to provide for technician level qualifications, ie national certificate with some tentative consideration to be given to a national diploma based on assessment of outcomes after two years of work experience. (The NZC requires equivalent study and three years work experience.)

It has been indicated that the proposed national validation authority will take over the functions of AAVA and possibly the Trades Certification Board and other bodies. It is interesting to note the Director General's comments on AAVA in a paper on "Universities, Technical Institutes and Teachers Colleges : Dividing Lines and Common Interests".

> "A national authority thus exists which, as its new name implies, has the responsibility for the award of advanced vocational awards. How it will develop is one of the interesting questions of the future". (Renwick 1981 : 18)

For its own qualifications, the Authority has asserted that for professional purposes the NZ Diploma (as a post NZC qualification) provides the technician with a qualification which is degree level equivalent. Examples are the NZ Diploma in Science and the NZ Diploma in Building. There is a case for the introduction of a NZ Diploma in Engineering for NZCE technician engineers who may not wish to attend university. Further reference will be made to qualifications for a hi-tech future.

In his paper Professor McCallion referred to the low number of students completing NZ Certificates and referred to a drop-out study (NZCER 1986). One consideration of the study not mentioned was the difficulty that many students found in coping with the mathematics required for technician engineers (NZCE: Stage 4).

Mr Griffin has also drawn attention to problems related to mathematics and science for school-leavers and this will be discussed later.

At this point, it is important to supplement the information in Professor McCallion's paper. A particular and equitable characteristic of NZ tertiary education is the low level of selection for entry to NZ Certificate and to most university programmes. Accordingly, a significant proportion having experienced such a tertiary programme "opt out" (own decision) as well as "drop out" (assessment outcome).

In a study of the provision of technicians for research and development (Imrie, McCallion, Thomas 1985) it was reported that the ratio of students entering NZCE and NZCS courses to those who complete the qualification is approximately 3:1. This is based on AAVA registration figures for the three year period 1978-80 compared with certificates awarded in 1981-83 for a period of four years corresponding to the minimum time required to complete NZC study and work experience requirements.

While this estimate only approximately represents minimum time completion, a study by Clift (1984) does provide comparable data for graduates at Victoria University. For BSc students starting in 1978, 32% graduated in the minimum time of three years; after five years 55.7% of the initial entry had graduated.

For both cohorts entering technical institute and university courses in 1978, it is probable that school-leavers found difficulty in coping with science (and mathematics) at the tertiary level.

GOVERNMENT AND EDUCATION

For this conference, it is pertinent to note Renwick's comments in the same paper with reference to bodies such as IPENZ.

> "There is the possibility of conflict of interest between the professional aspirations of the associations that will be seeking to advance the interests of their occupations and others who will be called upon to advise on how best to provide courses of vocational education for particular groups." (Renwick 1981 : 28)

As Director General of Education, Mr W L Renwick is the Minister of Education's chief official and adviser and the above quotation is particularly pertinent in view of recent decisions which will transform the education and training of technician engineers and their qualifications. It is fair to say that the decisions to introduce a two year National Certificate in Electronic Engineering and to dispense with the concurrent work experience of the NZCE, were taken without consultation with industry in the form of professional associations such as IPENZ or employer organisations such as NZ Manufacturers Federation or employee organisations such as Federation of Labour.

During 1986 the Minister and his officials (including Mr I Young, Assistant Secretary Tertiary and Mr J R O'Connor Director of Continuing Education) have spent many hours debating and negotiating issues relating to a Green Paper on Vocational Education and Training (VET) proposed by the Minister of Employment and his officials. The debate was conducted under the seemingly disinterested chairmanship by the Hon Richard Prebble of an Ad Hoc Cabinet Committee on Employment and Training comprising, in addition, the Ministers of Education, Employment, Maori Affairs and Social Welfare. In attendance were officials from Education, Labour, Maori Affairs, Women's Affairs, Social Welfare and Treasury.

In November 1986, at the TIA Conference, the Minister of Education stated that there would now be no Green Paper on vocational education and training. Instead Government considered papers from TIA, Association of Teachers in Technical Institutes (ATTI), VTC and from officials and has made a number of decisions. Some of those decisions were announced in December 1986 (to start in 1987) including full-time courses for apprentices and technicians and 31 Foundation Courses for students who had not obtained sufficient advantage from school and life experiences.

The education and training of technician engineers does need to be systematic and does require effective systems to co-ordinate the resources of industry, government, education and professional organisations to provide opportunities for people and to meet the needs of employers. However, in NZ, consideration of the transition from school to work has paid little attention to requirements for the education and training of technicians. The Report of the Educational Development Conference Working Party (EDC) provided an inadequate discussion of technician education and development, but did include a definite statement about the "world of work":

> "There is no doubt that somehow the rather inflexible boundaries between the school and the world of work must be readjusted if each is to gain from the particular educational strengths and resources

of the other". (EDC 1974 : 16)

The "inflexible boundaries" are predominantly those of attitude and awareness - on the one hand with regard to "industry" by teachers and on the other hand opportunity for industry (ie employers and planners) to influence principal aspects of curriculum. This will be discussed later.

It is still pertinent to note (also in 1974) the recommendation of the Advisory Committee on Educational Planning (ACEP 1974):

> "That the staffing of the technical directorate of the Department of Education be strengthened to enable it to assume a greater degree of professional leadership."

During the 1980s the responsibilities of the Department for technician education have been affected by frequent changes in the Director of Continuing Education. Generally, it may be observed that officials have little direct experience of the education and training of technician engineers.

Even the OECD (1983) Examiners in their Review of NZ Policies for Education, briefed by Department officials, did not seem to be sufficiently aware of technician education to mention the work of AAVA established as the national statutory body responsible for setting standards, prescribing courses and work experience, and conducting examinations for advanced vocational awards.

Far too often national reports or discussion papers, eg "Employer Approach to Vocational Training" (NZEF 1984) have confused technician education with apprentice training and neglected the former. In 1985 the NZ Planning Council published a planning paper on "Young People, Education and Employment" (Catherwood 1985). There was no discussion of technicians and the only two references to the NZ Certificate as a post-secondary qualification were both wrong.

Current problems, therefore, relate to years of neglect, lack of awareness and an absence of the policy co-ordination by employers, government and the TI system, essential for development of the appropriate quantity and quality of technicians for the future. McCallion correctly then draws attention to the need for an effective system and for the management implied.

THE TI SYSTEM

This phrase is used to describe the relationship between AAVA, the Department and the 22 technical institutes and community colleges (TIs) with reference to technician education. As noted, AAVA is the national body which has prescription examination, certification and validation functions for technician courses and qualifications. AAVA also has an accreditation function which, in practice, is assumed by the Department by virtue

of its current policy of granting staffing, funding and TAG approvals without which courses cannot be offered.

The most important function of AAVA, however, is to provide for a sub-system of course committees and prescription committees to determine the content, levels of learning and assessment requirements of technician courses. Membership of these committees reflects the interests of the TI system, the Department employers and professional organisations usually with a majority of "user group" representation.

The Green Paper negotiations which also involved officials from Treasury, and Trade and Industry (but not Science and Technology), have produced the following statement of principles of vocational education and training which are being used to restructure technician education.

> "Government has recognised a need for an efficient and equitable system of recognition of student achievement which is:
>
> (a) based on validation rather than prescription;
>
> (b) assessed on achievement rather than time served;
>
> (c) flexible and permits cross-crediting and portability."

Clearly, there are implications for a national minimum standard of performance and a system which will provide the necessary quality assurance. As such, the TI system will change and the following developments have been pronounced upon by the Minister and his officials:

1. The generic name of the system will change from "technical institutes and community colleges" to "polytechnics"."

2. Councils of the regional institutes (which are not polytechnics) will be asked to consider changing the name to that of polytechnic.

3. The Minister expects to consider the implications for the two institutes which have a national role, viz the NZ Technical Correspondence Institute (TCI) and the Central Institute of Technology (CIT).

4. Committees have been established to make recommendations for establishing a body with similar functions to that of the University Grants Committee which may emerge with a name such as New Zealand Polytechnic Authority.

5. There is an intention to set up a national validation

authority which might incorporate functions and responsibilities of organisations such as AAVA, TCB and VTC. In this context Government is reviewing the present profusion of awards and bodies that are involved in examining, certifying, validating and registering students. This reflects decisions (in 1986) by the Ad Hoc Committee on Employment and Training to move from the existing examination structure to a certification system based on validation.

6. Finally, as stated by the Prime Minister in "The Shape of the Future"

> "The Government will undertake a review of tertiary education this year. It will examine options for radical change in the management of universities, technical institutes, teachers colleges and other institutions. The object of the review will be to ensure that tertiary education is managed in such a way as to meet the requirements of those undertaking training." (Lange, January 1987)

"THE KEY TO PROSPERITY : SCIENCE AND TECHNOLOGY" (Beattie 1986)

In considering the technical institute system, the Beattie Report confirmed substantial and continuing government investment in tertiary technical education and noted that "the technical institutes have an excellent record of close liaison with industry through various systems of advisory committees" (p 112).

However, concern was expressed about effectiveness with reference to the funding of staff to present the courses needed by industry, and to the duration and outcomes of vocational education and training programmes. With regard to the former the Beattie Report states that more flexible staffing arrangements are required including funding from industry. (CIT has established CITEC with the primary objective of mounting self-funding courses for industry, but matters of legality have frustrated progress.)

The implications of training programmes for the learner will be discussed later.

The Beattie Report has proposed the setting up of a Science and Technology Advisory Board (STAB) and has recommended as an early Task that

> "STAB investigate the staffing and other measures needed to allow for research and development in selected areas in technical institutes and to report to government accordingly." (pp xi, 38)

This was the theme of the CIT submission to the Beattie Working Party which noted, in the Report, that the funding system and conditions of service of tutors "effectively preclude significant research and development". (At present the conditions of service of tutors may be summarised as 40 weeks with not more than 34 hours attendance, not more than 24 hours class contact in one week and not more than 800 hours class contact in one year. Teaching normally extends over a period of 37 weeks.)

The Beattie Report considered that some R & D activity would greatly improve teaching standards and identified electronics and medical therapy (or paramedical science) as examples of areas where R & D would be particularly appropriate.

The Beattie Report on science and technology is, in effect, the first major submission to the Government's review of tertiary education. The recommendations would mean radical change in the management of technical institutes and CIT would welcome such change.

INDUSTRY

For the purpose of this discussion, industry will be used to refer generally to the employment organisations of industry, commerce and government. The Beattie Working Party identified land based production, financial institutions and advanced manufacturing technology as the triple foundation for a vigorous economy requiring a commitment to achieve. The Report, as noted previously, stresses the need for technically trained and literate people at all levels in industry.

This emphatic obligation for government is clearly of direct relevance to providing technicians for the hi-tech future of NZ industry bearing in mind the identified significance of advanced manufacturing technology. There is a responsibility for industry to work with government and the TI system and this section will discuss some of the implications of the system required.

In view of the focus of this conference and the limitations of time, consideration of the needs and views of industry will be restricted to examples considered to be representative of hi-tech with reference to manufacturing technology and software development.

In 1986, for the first time, the AAVA Handbook provided students with the opportunity to register for the NZ Certificate in Manufacturing and so qualify as technician engineers. The development of this NZ Certificate owes a great deal to the

efforts and foresight of Professor McCallion representing the Engineering Industry Training Board (EITB) on the AAVA Course Committee for Engineering and Draughting. (In passing, it may be noted that it was not until 1986 that employment bodies such as the NZ Employers Federation were recognised on the Authority.)

In a keynote address to the 1986 IMechE conference on UK Research in Advanced Manufacture, Lord Gregson (Executive Director, Fairey Holdings) commented that the UK (industry) was failing badly to keep up with the rapid pace of development of technology.

> "The manufacturing industry is absolutely vital to the economic well-being of the United Kingdom and the stupidity of saving otherwise must stop". (Comment CME 1987)

Lord Gregson quoted the statement of the US Congress Office of Technology Assessment, that knowledge in computer science has a half-life of 2.7 years and commented that too many UK universities do not provide courses in manufacturing technology. Microcomputer based (hi-)technology is essential to the processes of manufacturing and their management, and the development of software is of crucial importance. For example, the (computer integrated manufacturing automated protocol is already a set of 1SO standards (CIMAP 1986).

In his book on computers and communications (C & C), Kobayashi (1986) discusses the importance of develoments in processing digitalised information through semi-conductor circuits. As chairman of the board and chief executive officer of the NEC Corporation (R & D and Engineering budget, 1986, of US $1,836 million), Kobayashi considers that it is vitally important to deal with problems related to the shortage of software engineers.

> "Moreover, because more than 70 percent of software engineers are engaged in maintaining the huge amount of software already developed, there is a tendency to delay new development work." (p 84)

Kobayashi observes that educational systems will need to be developed to make it easy for people to learn about the software in C & C technology and stresses the importance of international co-operation. In NZ this has been brought about by NEC establishing, in 1982, NZ Telecommunications Systems Support Company (TSSC) as a joint venture with NZ Post Office (51%), NEC (40%) and Wm Scollay (9%) as shareholders (who are thanked for donating two copies of Kobayashi's book to the CIT library).

In the UK (Engineering News 1986) it is estimated that the engineering industry will invest 700 million pounds in computing to improve its efficiency and productivity, with 200 million pounds of this being spent on engineering software. The National

Computing Centre has produced a second edition of its "Guide to Computer Aided Engineering, Manufacturing and Construction Software" which details nearly 1100 engineering related software packages available in the UK.

In the same issue of "Engineering News", the UK Engineering Industry Training Board (EITB) is reported as taking urgent steps to combat the serious skill shortfall in software engineering "which is blocking the growth of some high tech businesses".

> "A recent survey among 25 companies has shown that a new breed of technician engineer can do much of the work now done by graduates in the software engineering industry."

The EITB is initiating, nationally, appropriate courses of education and training in the form of National Certificate and Diploma programmes (for software technician engineers) and Ordinary National Certificate programmes for software technicians.

This initiative would seem to be in accordance with the NZ Government's decision to introduce two year national certificate programmes for technician engineers and Department consideration of subsequent diploma programmes. This also corresponds to the proposal by Professor McCallion in his paper. A similar proposal with two years' post study work experience for NZC, was submitted in 1984 to the Scott Committee on Transition Education indicating the need for a vocational bursary as equity funding for non-university students (Imrie 1985b).

Such developments will require radical change in the TI system. Change will also be required in industry if, nationally, the NZC (incorporating three years' work experience) is replaced by a national certificate with no work experience. The latter programme should provide the generalisable problem solving skills advocated widely (eg Marshall 1984; DSIR 1986) and it will then be the responsibility of industry to provide systematic education and training experiences to develop and maintain the investment that a skilled employee such as a technician engineer represents. As such industry-based learning must have recognition and this is discussed later.

Coopers and Lybrand (1985) reported that, in the UK, few employers think that training is sufficiently central to their business for it to be a main component in their corporate strategy; the great majority did not see it as an issue of major importance. Their report on "Changing Attitudes to Training" was sponsored by the Manpower Services Commission and the National Economic Development Office.

In NZ, Progeni is a company very much concerned with software development and with the develoment and use of new technology in education and training. The Managing Director, Perce Harpham

(himself an engineer), has commented on training and technology as unemployment solutions and also as investment to take advantage of technological opportunity (Harpham 1986a). He is very concerned that industry-based training (at all levels) continues to be neglected by national policy as the essential adjunct to institution-based learning.

> "Our national attitude to intellectual capital is one of complacency and disdain. We are fond of claiming we have an educated workforce when what we really mean is that employees were educated in something once upon a time." (Harpham 1986b)

Harpham has set out proposals for Government to provide subsidies for training within industry, but has found no acceptance because "this Government doesn't believe in subsidies". Reference has already been made to CITEC established to meet the training needs of industry for employees at all levels. Training programmes can be conducted in the workplace (with hi-tech facilities, eg robots) or at an institute such as CIT for convenient use of facilities such as computing laboratories, library facilities and accommodation. Of particular significance is the use of distance learning in industry as described by Stephen (1986) with reference to an organisation set up jointly in Scotland by Heriot-Watt University and the EITB with financial support from the Department of Trade and Industry.

IDENTIFYING NEEDS, RESPONDING TO DEMAND

In general, industry needs educated and trained personnel (employees and employers) to ensure continuing development and productivity. Industry can be considered as an "employment system" which has staffing inputs and outputs, which contains staffing changes (eg levels and categories of occupation within the industry) and which has needs and demands that change with time, ie a dynamic system. In a technical sense this kind of system requires "adaptive control" which, by responding to information obtained from monitoring performance, makes adjustments to ensure optimum performance of the industry or system.

Such a system, however, has linkages which may need further development to ensure appropriate identification of needs so that there can be effective response to demand. Consideration should, therefore, be given to the following matters.

(a) Which persons or organisations have responsibility for the well-being, ie maintenance of the industry system? Government is usually represented by Ministers (and their officials) and the industry is represented variously by industry training boards, by unions and by industry/employer federations. Are there effective linkages between these various areas of responsibility to ensure

identification of needs, throughout the industry and over an appropriate time scale?

(b) Effective response implies meeting a demand in time to avoid deterioration in the performance of the industry (system). The process of identifying needs at various points in the future of a developing and productive industry, is a continuing process and translates (from time to time) into staff numbers (quantity) at different levels in different sectors of the industry. The demand is, therefore, for sufficient numbers of appropriately trained people to ensure optimum industry or system performance (quality).

(c) Training can itself be optimised by providing appropriate on the job and off the job (education and) training. On the job training is organised by industry and is related to employment, to the advantage (presumably mutual) of the employer and the employee. Off the job training, typically, is provided by the TI system. There is a growing need for formal recognition of industry-based training to complement TI-based training for vocational qualifications, and for the respective programmes to be co-ordinated. Are there effective linkages between these forms of training?

Are there effective linkages between the TI system and Government (Department of Education), and between industry to identify needs so that demands can be satisfied allowing for the lead time involved in the provision of training?

Questions have been raised about the linkages required for system performance. Characteristics (or assumptions) which affect the linkages are:

(1) Industry expects Government to pay for basic pre-employment training provided by the TI system and usually leading to a qualification.

(2) Government expects industry to pay for on the job training which is usually specific to the needs of the individual.

(3) In-service training may be provided by industry or organised in association with the TI system in the form of short course in-service training, usually not leading to a qualification (but having that potential through suitable development and validation).

(4) School leavers expect training places to be provided in the TI system and need support while in training (also expected to be provided by Government).

(5) Industry expects to identify needs and to decide what training is appropriate and expects the TI system (and

Government) to respond to the demands for that training. Industry expects to be consulted when the TI system makes decisions about providing training either in the form of qualifications or through short courses.

(6) The "system", therefore, needs to be able to identify who should represent industry for the purposes of identifying needs so that the response is acceptable with reference to the content, availability and outcomes of courses designed to meet industry demands.

A recent survey "Education and the Economy" undertaken by the Vocational Training Council (1986) suggested that technical institutes were "insensitive to changes in the economy, technology and business in general. Leaders in industry said that Government should spend more money on education and that there should be better control over expenditure. (The survey did not attempt to measure the factual accuracy of respondents' statements.)

The question again is, "What mechanisms are required to ensure "sensitive" response and the effective provision of resources?", or "Who will monitor the investment performance?"

Each "Industry", in conjunction with Government and the TI system should consider setting up Training Liaison and Development (TLD) Units to organise the information and procedures needed for intelligent and timely decision-making. TLD Committees would determine policy and resources issues, with membership representing the appropriate organisations of Government, industry, education and training.

> "Despite diverging views about the responsibilities of the State and enterprises, there is much agreement that some kind of central arrangement is needed in each country to oversee the system and guide its development. Whatever the arrangements countries find appropriate, high priority tasks are to secure a consensus about the organisation of practical training in firms; the co-ordination of curricula in institutions and firms; the arrangements for certification and standards." (Bollard 1986)

SHORTAGES IN THE FORESEEABLE FUTURE

In this section there will be a brief review of shortages of skill levels and of people with skills for future technological developments in New Zealand. In considering the importance of science and technology for NZ economic and social development, the Beattie Report stated that R & D must play an important role in sectors other than primary industry and identified as examples tourism, transport and the communications and information technology industry. The Report considered that research expertise is not being fully used in NZ universities because of lack of funds for support staff with a ratio of academics to technicians of 1:1.2 compared with 1:2 (Australia) and 1:3 (UK).

In NZ the current output of technicians just maintains a ratio of 1:1 for technologists:technicians in engineering and 1:1.25 for scientists:technicians generally. Imrie, McCallion, Thomas (1985) in their NRAC review paper considered the projected growth rate of three percent for R & D and estimated that a 2.5 fold increase in qualified technicians was required by the year 2000, from approximately 900 in 1983.

As noted by Clark and Vere-Jones (1987), a school of 1,000 students should have at least two full-time science technicians compared with the NZ average of one half. Recommended figures for the UK indicate one full-time technician for every four to five science teachers (about four times the NZ average).

A report on information technology manpower in the 1990s from the Institute of Manpower Studies (IMS 1986), warns that there will be a serious shortage of skilled professionals in information technology unless higher education and industry collaborate to improve the situation. The report assumes an industry growth rate of 10 percent and estimates demand for IT graduates increasing by 50 percent up to 1990. A principal conclusion is that

> "Companies need to be more flexible in the recruitment of staff and collaborate with higher education establishments in providing continuing education programmes in IT."

In a chapter on "New Technologies" in a book on continuing education, Chisholm (1985) considers distance teaching and the use of IT in training engineers (eg "Cyclops" - a system developed by the Open University and used by British Telecom). Chisholm cites "alarming" shortfall figures for qualified engineers and concludes that "a massive additional educational and training effort will be necessary if Britain is to have the skills necessary to keep up with international competition".

"International" is a key word when considering foreseeable shortages of skilled personnel at all levels in NZ industry. It is already evident that UK and Australian companies are recruiting from NZ, thereby aggravating the problem.

The Beattie Report identifies "just two major obstacles" to NZ doubling its GDP per capita over the next 10 - 15 years. One is R & D performance, the other is "NZ's failure to produce sufficient numbers of technically literate and numerate people at all levels for the new industries needed".

MATHEMATICS, SCIENCE AND THE LEARNER

Technically literate and numerate people need to have had some experience of mathematics, science (physics or chemistry)

and industry. All of these should be important subjects at school taught by young men and women who have the potential to be the technicians of a high-technology future.

In this section attention is drawn to "insufficiency"

(a) insufficient numbers of students taking mathematics and science at school as a prerequisite for opportunities of post-secondary technological education and training.

(b) shortages of mathematics and science teachers at primary and secondary level (with industry awareness or experience?)

(c) the insufficient nature of the mathematics and science curricula with reference to vocational relevance rather than university orientation.

The learner is being disadvantaged by a system which does not provide adequately for the learner to make informed choices about subjects or for the subjects to be presented with vocational relevance for the large majority (85%) of school leavers who will not go to university. The principles of course structure and assessment are not equitable for the individual learner ie the educational opportunities are not fair.

A previously mentioned UK study (IMS 1986) on the shortage of skilled professionals in information technology considered that a shortage of good mathematics and physics teachers is a serious underlying cause.

In the UK, the Engineering Council (1986) has published a document "The Shortage of Mathematics and Physics Teachers" with a proposed series of actions. A few weeks after publication the Secretary of State announced a plan to spend 16.5 million pounds to train or retain teachers in maths, science and craft design and technology to combat the shortage. This action was undoubtedly prompted by the failure of the government's scheme offering an extra grant to maths and physics graduates to be trained as teachers. "The Guardian" is quoted as saying that "it is beginning to look as though the government's educational policies will do more harm, over a longer timespan, than its economic policy has done to manufacturing industry" (GCCA 1986).

James Pryor is a senior British MP and also Chairman of the General Electric Company. In 1985, in a memorial lecture on "Government in Industry", he commented:

> "A real increase must be achieved in the number of young people qualifying in mathematics and physics at 16 and 18 years of age."
>
> "And as soon as possible the UK must find new methods to overcome the notorious learning difficulties which some youngsters with ability have in mastering mathematics and physics."

Bollard (1986) noted that, in 1982, the Royal Society (UK) published the Pitt report on science education in secondary schools which advocated all school leavers knowing what science is; all courses should embrace chemistry, physics and biology and at least 20% of students' time should be spent on science, with mathematics additional to this.

Similar concerns are evident in the USA and in Australia, but the parallel with UK school education is strongest for NZ school education as evident in the book "Education for Capability" (Burgess 1986). The traditions are the same as are the current unsatisfactory outcomes.

In NZ the Chairman of the 1986 (NZ) National Electronics Conference, Dr Lewis, summarises the problems very clearly:

> "Unfortunately, the dearth of qualified physics and mathematics teachers in our high school results in many children being deprived at a critical time in their educational development of the basic teaching necessary for them to achieve their full potential."

This undoubtedly is an equity consideration fundamental to the education of the individual.

Unfortunately, this shortage is borne out by a recent study by Clark and Vere-Jones (1987) presented to the 1987 ANZAAS Conference in which they conclude:

> "(In a) typical state secondary school of 100 students, and looking at third and fourth forms together, out of perhaps 17 classes, one will have no regular mathematics teacher, two or three more will be taught mathematics by a teacher with no post-secondary mathematics qualification, two or three will be taught science by a teacher with no science major and more than half will be taught science by teachers who have no post-secondary physics. The school is unlikely to have more than one teacher with a physics major on its staff. The situation in mathematics may well have worsened during the last year (1986)."

But in NZ there is a more serious problem with mathematics and science in the primary school, due partly to stafing and curriculum in both primary schools and teachers colleges, and due partly to selection of trainees. Clark and Vere-Jones (1987) discuss this in more detail in their paper, but comment pertinently on the findings of the second IEA study (Department of Education 1986). One of the major findings for NZ Children was that in 1981 their performance at 3rd Form level in basic mathematics was well down by comparison with virtually all the OECD countries. That performance is derived from primary

school experience for which the CERTECH (1986) study recommended as an objective.

> "To persuade the teacher training colleges to incorporate appropriate courses over three years to boost significantly the confidence of primary teachers in quantitative reasoning so that far fewer will unwittingly transmit fear of numbers and size to their pupils".

This also is borne out by Clark and Vere-Jones (1987) when they comment that when primary school children are faced with teachers who are unable to explain mathematical concepts and procedures, "the danger is that the children will learn from their teachers only the attitudes that go with them". They refer to the meagre 72 hours of science content spread over three years of a teacher training course. At the same training college, for far too many years, no criterion-referenced standards or indeed norm-referenced standards, were required for the mathematics content of the course and assessment policy was typically represented as self-reference, eg "if the student shows improvement that is satisfactory".

However, mastery principles are now being introduced at last in such colleges and, indeed, in primary schools. The curriculum officer with the NZ Education Institute has reported that, starting in 1987, progress checks will be a built-in part of the mathematics programme to ensure that every child has mastered their work before they are allowed to move on to the next stage.

But the legacy of at least a decade of neglect must raise the question of accountability at Training College level, at Department level, at Ministerial level and at Government level.

RELATED CONSIDERATIONS OF CURRICULUM

The previous section considered mathematics and other science subjects with regard to insufficiency and inadequacy. There are other curriculum considerations and recent curriculum additions have included peace education, trade union education and health education. In the foreseeable future understanding of these subjects will be of potential benefit to the school leaver, but "industry" or the world of work should also be part of the school educational experience since it is part of the future of New Zealand.

As noted earlier, the report of the Educational Development Working Party referred to inflexible boundaries between the school and the world of work separating the respective educational strengths and resources. In 1983 the OECD Examiners reported on NZ education policies and commented that,

> "Teachers in secondary schools are not felt to be sufficiently well informed about the work of technical institutes, and to be biased towards academic rather than industrial futures for their pupils". (p 35)

They also made the point that the curriculum and values of existing secondary schools need "some adaptation" for preparation of students for non-university tertiary institutions, and subsequent employment in industry and commerce.

In 1984 there was an unsatisfactory review of the core curriculum (1600 submissions) which was put on hold while the education portfolio changed hands. Then the Minister of Education established a committee to review the curriculum in schools, in association with the Inquiry into Curriculum Assessment and Qualifications in Forms 5 to 7. The draft report of the Curriculum Review (1986) represented consideration of 21000 submissions but there seemed to be weaknesses of methodology which gave rise to superficial consideration or neglect of considerations relevant to this conference. The CIT (1986) submission referred, for example, to the sole proposal relating to mathematics and science which advocated catch-up classes for senior students who "missed out at an earlier age" and commented

> "This really does not recognise the extent or the nature of the problem and is a serious weakness in the curriculum proposals of this Review".

Clark and Vere-Jones (1987) note that proposal was not based on discussion or reasoning and they are appropriately trenchant in their conclusion

> "It is amazing that a statement of this kind could be left to represent the sum total of the Committee's thinking on an issue of national importance in a major policy document." (p 13)

While the Committee of Inquiry (Forms 5 to 7) noted that schools have a major responsibility to prepare students for the world of work, the intended association with the Curriculum Review has not managed to translate this "major responsibility" into the curriculum (at least at the draft report stage). The appropriate statement required would be "knowledge which develops students' understanding of the world of work" (CIT 1986).

For young men and women in school, and for many who have left school, their educational experiences as learners have not been satisfactory and have not, in terms of Principle 4 of the Curriculum Review, allowed all students to enjoy "significant success". Students have been set learning tasks

they cannot be expected to accomplish and they have been disadvantaged by assessment assumptions and procedures. For many students the experience has been lacking in both education and equity. The Curriculum Review missed a unique opportunity to establish a "Bill of Rights" for the student with reference to the curriculum.

THE FORESEEABLE FUTURE

Having offered an analysis of aspects of the problem of providing technicians and technologists for the future, there is a responsibility to consider how foresight can assist with finding solutions. For a particular country at a particular stage of development, foresight can be derived by considering the experiences of other countries which are considered to be "ahead"; it is then possible to learn from experience. Such advantage of foresight may also be obtained from "reading the literature" of technological development both current and forecast. Finally, foresight is available from reflection and from the opportunities of discussion presented by conferences such as this. The following suggestions derive from such foresights.

At Government level it is suggested that the Ministers of Education and Employment should continue to work together and develop a shared political structure and responsibility for co-ordinating the systems required for vocational education and training. Relevant examples of experience can be found in Portugal and in Scotland (Imrie 1985a). The advice to Government from the Beattie Committee is quite clear. For identified areas, investment in science and technology is essential if there is to be real development of the NZ economy. The investment must include new initiatives and incentives to develop the previously neglected potential of young men and women to become future technicians and technologists.

At Department level it is important to note the growing contribution of the Director of Continuing Education, Mr Rory O'Connor, and his staff to the future development of an independent system. The Division is coping with an unprecedented level of change (which is also affecting individual TIs) and is using staff secondments from the TI system to provide the additional value of first-hand experience.

At primary and secondary school level there are shortages of mathematics and science teachers, and there is a general lack of vocational experience with reference to industry and the TI system. As noted previously, similar problems have occurred in the UK and potential solutions proposed and implemented for recruitment, training and retraining. Here is an obvious opportunity to learn from experience. However, the lead time to cope with the magnitude of the problem is

considerable and an interim solution is proposed by Perce Harpham, Managing Director of Progeni.

He considers that educational technology and information technology are sufficiently advanced to design, present and deliver modules to meet the needs of individual students in urban or rural areas throughout NZ. He proposes task groups of subject specialists working with appropriate educationalists, industrialists and information technologists to prepare high quality teaching materials, eg in mathematics.

In the UK, the Information Technology Development Unit (ITDU) is pioneering the use of advanced information technology at all levels of learning.

> "By combining experienced teaching staff with extensive expertise in the latest technologies, significant advances in training programmes for both industry and education are being developed." (ITDU 1987)

Classroom teachers would be trained in the management of these materials and of the assessment procedures, in itself a form of retraining for all teachers. The outcome would be equitable in that, regardless of the location of the school or the parental income, a high quality minimum standard of teaching would be available. The cost would be offset by the money currently spent on recruiting staff from overseas, but would in itself be part of the required investment. A similar strategy could be used to introduce "industry studies" to the curriculum.

A priority area identified by the Rev Canon George Tolley (1985), Chief Officer, Review of Vocational Qualifications (UK) is initial teacher training stimulating an awareness of industry. Perhaps prior or concurrent industry experience (discarded for the NZC) should be considered?

At the learner level the Curriculum Review has asserted as a principle that all students should enjoy significant success and that "no students will be set learning tasks they cannot be expected to accomplish". In his paper Don Griffin described such a system with reference to the Scottish 16+ Development Programme which is under consideration by a Department committee chaired by the Director of Continuing Education. On the basis of a full year's work comprising 24 modules (eight per term) students, advised by teachers, choose the particular modules they are likely to pass (no grades). Such an education programme has a built-in "myth" ie "equity of educational experience" as described by Van Aalst (1980).

> "Such a strategy relies on acceptance of qualitatively different levels of outcome in contrast to expectations of predetermined uniform outcomes."

In other words, in any one year, some students will pass more modules than others but all students are likely to pass all of the modules tackled. The system is thus more equitable than expecting all students to study a subject for a year and then be ranked in performance as a measure of achievement.

At the technical institute level where will the learners come from? It is evident that TIs should accept students without mathematics or science at the appropriate levels and, if no time can be found in a course, provide bridging courses to meet a "catch-up" requirement. Such bridging courses which might be run as summer schools would also provide retraining or return to the workforce opportunities. Again, from a curriculum point of view, the 16+ modular programme would be particularly relevant since the module principles could be readily applied to another priority identified by Tolley (1985), that of recognition of work-based training. The facilities of industry could then be used more effectively and be integrated with TI facilities for co-ordinated programmes of technician education and training.

This would be in accordance with the observation in the Beattie Report that "new approaches to curriculum design may be needed for some technicians in the modern setting". A third priority identified by Tolley (1985) is also that of curriculum development. Tolley considers that it is not enough for industry and the professions to be involved in curriculum development at the national level because there is "no guarantee that the context of teaching will reflect that contribution". He proposes advisory committees with co-operation between industry and TI on course content and methods of assessing outcomes.

CREDENTIALISM

In his closing remarks, Don Griffin invited consideration of a national validation authority validating non-university courses (in the TI system) as unclassified or ordinary degrees. This would contribute to equity in education in that an alternative path would be available for many students who would prefer a TI course to a university course.

Pending such development, perhaps IPENZ could consider the degree-level equivalence of the NZ Diploma and the National Diploma. The NZ Diploma in Science has NZC as an entry requirement and is awarded after successful completion of a project (and report) over a period of two years. The project is industry-based and assessed jointly by an industry supervisor and a TI supervisor. It, therefore, meets the curriculum requirements referred to earlier. Moreover, most of the projects have been assessed at the Honours level and the NZC, NZ Diploma graduate is for professional purposes degree level equivalent.

Consider then a National Diploma in Engineering for holders of the NZCE, many of whom would wish to study further but for various reasons do not wish to attend university for two years. A programme (say) of a 12-week block course followed by a project over a two year period would produce a technologist of at least ordinary degree standard and worthy of full corporate membership of IPENZ.

MYTHS AND TARGETS

In this final section further consideration will be given to the rights of the learner with reference to a myth derived from the perceptions of Dr C E Beeby a former Director-General of Education. This is pertinent because of the place of myth in educational change (Beeby 1986a) and the purpose of this paper to recognise that change is needed to identify the future as a "moving target and to prepare accordingly.

Beeby (1986b) developed his perceptions of educational myths in an introductory essay to a book "Moving Targets" by Bill Renwick (1986) the current Director-General of Education. Beeby has identified three myths or "over-arching ideas", which have influenced the history and development of the NZ school system. In his introductory essay, Beeby considers that Renwick "offers at least the first component of a new myth" with his proposal that equality of results is more appropriate than the current prevailing myth of equality of opportunity with reference to lifelong education. Although Renwick does not use the word "equity", Beeby (1986a) uses it in conjunction with equality of results and equality of outcome.

These matters are particularly significant when one considers that Beeby, Director-General (1940-1960), was the architect of the TI system since developed under Renwick. This paper has argued for fundamental change to be brought about in schools on a national scale to complement the changes required in vocational education and training for a hi-tech future. What, therefore, can be learned from the collective insights of two men who have had such an influence on NZ education but who still look to the future?

Changes that are needed relate to content, assessment, awards, teacher selection and training, relationships between schools and industry and the rights of learners. It is not just a new curriculum and Beeby (1986a) has this to say about fundamental change:

> "But if you want to ... change the very objectives of education, change the kind of students who emerge from the school system, then you have at least a generation of work ahead of you. That calls

> for changes of attitude, not just in the teaching profession but also in the parents of the students, the employers and the country as a whole. Changing attitudes is a vastly slower business than changing skills and the tricks of a teacher's trade." (p 53)

But, Beeby warns, no fundamental change can be brought about in schools on a national scale "unless the average teachers understand the change, believe in it and, above all, accept it as their own idea". These are components of attitude and Beeby considers that the changes in myths correspond to changes in attitude to the place of the individual student in the school system.

Beeby sets out three myths

1. Myth of the SURVIVAL OF THE FITTEST (1877 - 1920)

2. Myth of the EDUCATION OF THE WHOLE CHILD (1920 - 1939)

3. Myth of the EQUALITY OF OPPORTUNITY (1939 -

Beeby attributes the third (and current) myth to Peter Fraser, Minister of Education, in his statement of government policy in education, in 1939. Beeby actually wrote the words to represent Fraser's policy presented here in an abbreviated form to focus this discussion.

> "... every child has a right, as a citizen, to a free education of the kind for which he is best fitted and to the fullest extent of his powers."

This can be interpreted as equality of opportunity, during the lifetime of a citizen whether male or female. But surely it is more than that? In passing it can be noted that the school student should have rights within the school system and this should have been addressed by the Curriculum Review.

Compare and contrast the above statement (and myth) with Principle 4 (of 14) of the proposed national curriculum principles:

> "The curriculum shall be designed so that all students enjoy significant success. Students will be extended, and challenged to strive for their personal best performance, however, no students will be set learning tasks they cannot be expected to accomplish."

This principle must accept "qualitatively different levels of outcome in contrast to expectations of predetermined uniform outcomes" (Van Aalst 1980) and it is then possible to identify the myth of equity of educational experience (in accordance with Beeby's myth characteristics). The outcome of such

educational experience is in accordance with the principle and is contrast to equality of predetermined results as represented by Renwick's conceptual proposal of "learning to be accomplished during 12 years of schooling" (p 42) and described thus,

> "... an educational system that provides equality of opportunity, expects all students to achieve predetermined standards during their years of primary and secondary schooling and, to achieve equality of results, is committed to matching educational resources to the needs of individual students." (p 44)

There is a clear difference between what a student needs and what a student merits. Renwick has asserted that rights are entitlements and it is this emphasis that justifies the myth of equity of educational experience as transcending the myths perceived by Beeby.

If NZ wishes to have the appropriate quality and number of technicians for the hi-tech future then change is needed. The change will require a generation of effort, commitment and investment from all concerned - government, employers, parents, teachers and learners (of all ages). Even with the benefit of foresight, the education of technicians will be a moving target. Equity of educational experience for the learner is essential.

TECHNICIANS, EDUCATION AND EQUITY
- with the benefit of foresight

RECOMMENDATIONS

1. **That IPENZ** collaborates with the Royal Society to ensure that every effort is made to ensure the supply of adequately trained technicians for the future development of NZ.

2. **That IPENZ** prepares a submission to the review of tertiary education taking note of the outcomes of this conference.

3. **That IPENZ** supports the validation of technical institute courses for technician engineers requiring advanced knowledge, for the award of unspecified or ordinary BSc degree.

4. **That IPENZ** supports the introduction of a National Diploma in Engineering for NZCE holders similar to the NZ Diploma in Science and degree level equivalent.

5. **That IPENZ** expresses concern to the Minister of Education about weaknesses in the Curriculum Review with reference to science and industry.

6. **That IPENZ** co-sponsors with industry development of a modular course on industry for Forms 3, 4, 5 and 6 using high-tech courseware.

7. **That IPENZ** co-sponsors with industry development of modular courses in mathematics, physics and chemistry for Forms 3, 4, 5 and 6 using high-tech courseware.

8. **That IPENZ** initiates discussion with NZ Manufacturers Federation and CITEC (Centre for Information Technology, CIT) about the provision of qualified technicians and technologists for manufacturing technology, through institute-based and industry-based programmes.

9. **That IPENZ** makes representation to the Minister of Science and Technology strongly urging the implementation of the recommendations of the Beattie Report.

10. **That IPENZ** invites the Ministers of Education and Employment to consider establishing a permanent joint responsibility for vocational education and training, recognising the need for technicians for the hi-tech future.

B W Imrie
IPENZ 1987

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"POLICY STATEMENT ON STANDARDS AND ROUTES TO REGISTRATION"

The Engineering Council, Canberra House, London WC2R 3ER

The Foreword describes the Statement as providing "a properly structured though flexible system for the minimum academic, training and Chartered Engineer (E Eng), a Technician Engineer (T Eng) or an Engineering Technician (Eng Tech).

The following definitions of the "Technician Engineer" and the "Engineering Technician" are taken from the Statement.

2.4 Technician Engineers

Technician Engineers perform technical duties of an established or novel character either independently or under the general direction of more senior engineers. They require the power of logical thought and, when in a management role, the qualities of leadership and effective control.

Fundamentally the nature of the posts occupied by Technician Engineers is such as to demand a practical approach and a detailed understanding of a particular technology. They require specific and detailed knowledge of the bases and practices of current existing technology efficiently. They also need communication skills and awareness of the environment beyond the limits of their specific responsibility.

Technician Engineers provide, either independently or as leaders, the most satisfactory service possible through existing resources and so exercise a significant influence on the overall effectiveness of the organisation in which they work.

Technician Engineers must, therefore, be competent by virtue of their education, training and experience:

(i) to exercise technical judgement in and assume responsibility for duties in the engineering field;

(ii) to understand, by the application of general principles and established techniques, the reasons for and the purposes of the operations for which they are responsible;

(iii) to be aware of the business, management, safety, social and economic context of their work both withn the organisation and in the wider environment.

2.5 Engineering Technicians

Engineering Technicians are competent by virtue of their education, training and practical experience to apply proven techniques and procedures to the solution of practical problems with an element of personal responsibility, usually under the guidance of Chartered Engineers or Technician Engineers.

Engineering Technicians will have an understanding of their duties by reference to general engineering principles applicable to their particular role, rather than by relying solely on established practices or accumulated skills. Additionally, Engineering Techniques require communication skills and other personal qualities, enabling them to work effectively as part of the engineering team.